WORKSHEET FOR REACTOR AND PLANT SYSTEM DEGRADED CONDITIONS

Reference/Title (LER #, Inspection Report #, etc): **BWR Example 1**

Factual Description of Identified Condition (statement of facts known about the issue, without hypothetical failures included):

Due to operator valve misalignment, the cooling water to the North Core Spray Equipment Room Emergency Cooler was not available. The licensee stated that the operator would have recognized the increasing temperature in the room and would have identified and corrected the misalignment. The condition existed for 12 days.

System(s) and Train(s) with degraded condition: **RCIC and One Core Spray Train**

Licensing Basis Function (if applicable): **RCIC - Core Heat Removal (Rx isolated - no FW), mitigate rod drop accident, HPCI backup. Core Spray - Core Heat Removal.**

Maintenance Rule category (check one): **__U__** risk-significant _____ non-risk-significant
Time degraded condition existed or assumed to exist: **12 days.**

Functions and Cornerstones degraded as a result of this condition (check T)

INITIATING EVENT CORNERSTONE

_____ Transient initiator contributor (e.g., reactor/turbine trip, loss offsite power)

_____ Primary or Secondary system LOCA initiator contributor (e.g., RCS or main steam/feedwater pipe degradations and leaks)

MITIGATION CORNERSTONE

___**U**___ Core Decay Heat Removal

___**U**__ Initial injection heat removal paths

__**U**___ Primary (e.g., Safety Inj)

__**U**__ Low Pressure

__**U**__ High Pressure

_____ Secondary - PWR only (e.g., AFW)

_____ Long term heat removal paths (e.g., contmt sump recirculation, suppression pool cooling)

_____ Reactivity control

BARRIER CORNERSTONE

_____ RCS LOCA mitigation boundary degraded (e.g., PORV block valve, PTS issue)

_____ Containment integrity

_____ Breach or bypass

_____ Heat removal, hydrogen or pressure control

_____ Fuel cladding degraded

PHASE 1 SCREENING PROCESS
Check the appropriate boxes **U**

Cornerstone(s) assumed degraded:

9 Initiating Event **:** Mitigation Systems **9** RCS Barrier **9** Fuel Barrier **9** Containment Barrier

If more than one Cornerstone is degraded, then go to Phase 2. If NO Cornerstone is degraded, then the condition screens OUT as "Green" and is not assessed further by this process.

If only one Cornerstone is degraded, continue in the appropriate column below.

Initiating Event	Mitigation Systems	RCS Barrier	Fuel Barrier	Containment Barrier
1. Does the issue contribute to the likelihood of a Primary or Secondary system LOCA initiator? **9 If YES ý Go to Phase 2** If NO, continue 2. Does the issue contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment will not be available? **9 If YES ý Go to Phase 2** **9** If NO, screen OUT	1. Is the issue a design or qualification deficiency that does NOT affect operability per GL 91-18 (rev 1)? **9 If YES ý Screen OUT** If NO, continue 2. Does the issue represent an actual Loss of Safety Function of a System? **9 If YES ý Go to Phase 2** If NO, continue **3. Does the issue represent an actual Loss of Safety Function of a Single Train, for > TS AOT?** **☒ If YES ➔ Go To Phase 2** **If NO, continue** 4. Does the issue represent an actual Loss of Safety Function of a Single Train of non-TS equipment designated as risk-significant under 10CFR50.65, for > 24 hrs? **9 If YES ý Go To Phase 2** **9** If NO, screen OUT	**9** 1. **Go to Phase 2**	**9** 1.Screen OUT	1. TBD

Result of the Phase 1 screening process: _____ screen OUT as "Green" **_U**____ go to Phase 2

Important Assumptions (as applicable):

Table - Initiators and Dependency Table

Affected System	Major Components	Support Systems	Initiating Event Scenarios
SRVs [2]	ADVS	Air/nitrogen, 125 VDC	Transient,[1] LOOP, SLOCA, MLOCA, ATWS
PCS	MDP TDP MOV	Offsite power, 125 VDC, TBCCW, air	Transient,[1] SLOCA
RHR	MDP HX	4160 VAC, 125 VDC, RHRSW, Pump Room HVAC	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
SBCS	HX MDP	4160 VAC, 125 VDC, SW	LLOCA, MLOCA, SLOCA, Transient, LOOP, ATWS
EDGs	Engine Generator	125 VAC, DGCW, EDG HVAC	LOOP
RHRSW	Pumps MOVs	HVAC, 4160 VAC, 480 VAC, 125 VDC	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
DGCW	MDPs MOVs	480 VDC	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
SW	MDPs MOVs	4160 VAC, 125 VDC, air	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
TBCCW	MDP HX	SW, air, 4160 VAC	Transient,[1] SBLOCA,
HPCI	TDP	125 VAC, 125 VDC, 250 VDC, SW, Room HVAC	Transient,[1] LOOP, ATWS, SLOCA, MLOCA
CS	MDP MOV	4160 VAC, 125 VDC, SW, Pump Room HVAC	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
SSMP	MDPs MOVs	SW, HVAC, 4160 VAC	Transient,[1] LOOP, ATWS
RCIC	TDP	125 VDC, SW, Room HVAC	Transient,[1] LOOP, ATWS
Air	Air Comp.	Offsite power, SW	Transient,[1] LOOP, ATWS, SLOCA, MLOCA, LLOCA
SLC		480 VAC, 125 VDC	ATWS

Notes:

1. Transient scenarios should be developed from those transient initiators that could have the greatest risk significance. For example, develop loss of DC bus transient scenarios for degraded 125v DC or AC power equipment, as well as other transient initiators that may depend on equipment being supplied from degraded power sources. The choice of which transient scenarios to develop should generally be apparent from the specific given condition.
2. Inadvertent opening of SRV is considered a small LOCA.

Row	Approx. Freq.	Example Event Type	Estimated Likelihood Rating		
I	>1 per 1 - 10 yr	Reactor Trip Loss of Power Conv. Sys. (loss of condenser, closure of MSIVs, loss of feedwater)	**A**	**B**	**C**
II	1 per 10 - 10^2 yr	Loss of Offsite Power Small LOCA (BWR) (Stuck open SRV only) MSLB (outside cntmt)	**B**	**C**	**D**
III	1 per 10^2 - 10^3 yr	SGTR Stuck open PORV (PWR) Small LOCA (PWR) (RCP seal failures and stuck open SVs only) MFLB MSLB (inside PWR cntmt)	**C**	**D**	**E**
IV	1 per 10^3 - 10^4 yr	Small LOCA (pipe breaks) ATWS-PWR (elect only)	**D**	**E**	**F**
V	1 per 10^4 - 10^5 yr	Med LOCA Large LOCA (BWR) ATWS-BWR	**E**	**F**	**G**
VI	<1 per 10^5 yr	Large LOCA (PWR) ATWS-PWR (mech only) ISLOCA Vessel Rupture	**F**	**G**	**H**
			> 30 days	30-3days	<3 days
			Exposure Time for Degraded Condition		

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period

PHASE 2 RISK ESTIMATION WORKSHEET **Transients**

Estimated Frequency (Table 1 Row) I Exposure time 12 days Table 1 result (circle): A (**B**) C D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Power Conversion System (PCS)	1/3 Feedpumps and 1/4 condensate/condensate booster pumps (Operator Action)
High Press Injection (HPI)	HPCI (ASD train) or RCIC (ASD train) or SSMP (operator action)
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (high stress operator action)
Low Press Injection (LPI)	1/4 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps with HX and 1/4 RHRSW pump in SPC (1 multi-train system) or SBCS (high stress operator action)
Containment Venting (CV)	Operator action
Late Inventory Makeup (LI)	1/4 Condensate or 1/2 CRD pumps (operator action)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence:	Sequence Color
1 Trans - PCS - CHR - CV (5, 9)			
2 Trans- PCS -CHR - LI (4, 8)			
3 Trans - PCS - **HPI** - DEP (11)	**1 (RCIC)**	**(PCS = 2) + (HPCI = 1) + (SSMP = 2) + (DEP = 1) Total = 7**	**B7** Green Result
4 Trans - PCS - **HPI - LPI** (10)	**1 (RCIC LPCS)**	**(PCS = 2) + (HPCI = 1) + (SSMP = 2) + (RHR = 3) + (LPCS = 2) Total = 11**	**B11** Green Result

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray is one single action (opening one cooling water valve)

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

Notes:

1. Safe shutdown makeup pumps (SSMP) can be manually started to provide alternative to RCIC or HPCI.
2. Operator action to initiate standby coolant supply (SBCS) is considered a high-stress action. QCPRA assigns a probability of 1.2E-1.

PHASE 2 RISK ESTIMATION WORKSHEET

SLOCA

Estimated Frequency (Table 1 Row) II Exposure time 12 days Table 1 result (circle): A B (C) D E F G H

Safety Functions Needed: *Full* Creditable Mitigation Capability for each Safety Function:

Power Conversion System (PCS)	1/3 Feedwater pumps and 1/4 condensate/ condensate booster pumps (Operator Action)
High Press Injection (HPI)	HPCI (1 ASD train) or RCIC (1 ASD train) or SSMP (operator action)
Depressurization (DEP)	1/5 ADS valves manually opened (high stress operator action)
Low Press Injection (LPI)	1/4 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps with HX and 1/4 RHRSW pump in SPC (1 multi-train system) or SBCS (high stress operator action)
Containment Venting (CV)	Operator action
Late Inventory Makeup (LI)	1/4 Condensate (operator action)

Circle affected functions	Recover of failed train	*Remaining* Mitigation Capability Rating for each affected sequence:	Sequence Color
1 SLOCA - PCS - CHR- CV (5,9)			
2 SLOCA- PCS - CHR -LI (4, 8)			
3 SLOCA - PCS - **HPI - LPI** (10)	**1 (RCIC/(LPCS)**	**(PCS = 2) + (HPCI = 1) + (SSMP = 2) +(RHR = 3) + (LPCS = 2) Total = 11**	**C11** Green Result
4 SLOCA - PCS - **HPI** - DEP (11)	**1 (RCIC)**	**(PCS = 2) + (HPCI = 1) + (SSMP = 2) + (DEP = 1) Total = 7**	**C7** Green Result

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray is one single action (opening one cooling water valve).

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

Notes:

1. Operator action to initiate standby coolant supply (SBCS) is considered a high stress action. PRA assigns a failure probability of 1.25 E-1.
2. Operator action to depressurize using ADS is assumed high-stress operator action. PRA assigns a failure probability of 5.2 E-2.
3. Containment venting may affect LPCI and LPCS components.

PHASE 2 RISK ESTIMATION WORKSHEET **Medium LOCA**

Estimated Frequency (Table 1 Row) V Exposure time 12 days Table 1 result (circle): A B C D E (**F**) G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Early Inventory (EI)	HPCI (1 ASD train)
Early Cont. Control (EC) **Depressurization (DEP)**	Passive operation of SP, 7/8 vacuum breakers remain closed and 1/8 open, when needed (1 multi-train system)
Late Inventory Control (LI)	Operator opens 1/5 ADS valves (High stress operator action)
Containment Heat Removal (CHR)	1/4 RHR trains in LPCI mode (1 multi-train system) or 1 / 2 LPCS trains (1 multi-train system) or 1/4 condensate train (high stress operator action)
Containment Venting (CV)	1/4 RHR pumps with HX and 1/4 RHRSW pump in SPC mode (1 multi-train system) or SBCS (High stress operator action)
	High stress operator action

Affected Sequences (circle affected functions):	Recover of failed train	*Remaining* Creditable Mitigation Capability for each affected sequence:	Sequence Color
MLOCA - **LI** (4,8)	**1 (LPCS)**	**(RHR = 3) + (LPCS = 2) + (COND = 1) = 7** **Total**	**F7** Green Result
MLOCA - CHR - CV (3,7)			
MLOCA - EI - DEP (9)			
MLOCA - EC (10)			

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray.

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

PHASE 2 RISK ESTIMATION WORKSHEET **Large LOCA**

Estimated Frequency (Table 1 Row) V Exposure time 12 days Table 1 result (circle): A B C D E (F) G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Early Inventory (EI)	1/4 RHR trains in LPCI mode (1 multi-train system) or 1 / 2 LPLS trains (1 multi-train system) or 1/4 condensate train (high stress operator action)
Early Cont. Control (EC)	Passive operation of SP, 7/8 vacuum breakers remain closed and 1/8 open, when needed (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pump with HX and 1/4 RHRSW pump in SPC mode (1 multi-train system) or SBCS (High stress operator action)
Containment Venting (CV)	High stress operator action

Circle affected functions:	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence:	Sequence Color
3 LLOCA - CHR- CV (3)			
2 LLOCA - **EI** (4)	**1 (LPCS)**	**(RHR = 3) + (LPCS = 2) + (COND = 1) Total = 7**	**F7** Green Result
1 LLOCA - EC (5)			

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray.

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

Note:

1. Containment venting (CV) is assumed a high stress operator action. PRA assigns a failure probability of 5E-2.

PHASE 2 RISK ESTIMATION WORKSHEET **Loss of Offsite Power**

Estimated Frequency (Table 1 Row) II Exposure time 12 days Table 1 result (circle): A B (C) D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Emergency Power (EAC)	1 / 2 EDGs or 1/1 SBO DG
Recovery of LOOP in 45 min (RLOOP 45 M)	Recovery of LOOP (high stress operator/recovery action)
Recovery of LOOP in 4 hrs (RLOOP 4 HR)	Recovery of LOOP in 4 hrs (operator/recovery action)
High Press Injection (HPI)	HPCI (1 ASD train) or RCIC (1 ASD train) or SSMP, except SBO sequences (operator action)
Depressurization (DEP)	1/5 ADS valves manually opened (high stress operator action)
Low Press Injection (LPI)	1/4 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps with HX and 1/4 RHRSW pump in SPC (1 multi-train system) or SBCS (high stress operator action)
Containment Venting (CV)	High stress operator action
Late Inventory (LI)	1/4 condensate train or 1/2 CRD pumps (operator action)

Circle affected Functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence:	Sequence Color **C10**
1 LOOP - EAC - **HPI** - RLOOP 45 M (25)	**1 (RCIC)**	**(EDG=3)+(SBODG=2)+(HPCI=1)+(SSMP=2)+(RLOOP45M=1) Total = 10**	Green Res
2 LOOP - EAC - RLOOP 4 HR (26)			
3 LOOP - **HPI** - DEP (10, 20)	**1 (RCIC)**	(**HPCI = 1) + (SSMP = 2) + DEP = 1) Total = 5**	**C5** Green
4 LOOP - **HPI- LPI** (9, 19)	**1(RCIC,LPCS**	**(HPCI = 1) + (SSMP = 2) + (RHR =3) + (LPCS = 2) Total =9**	**C9** Green
5 LOOP - CHR - CV (4, 8, 14, 18)			
6 LOOP - CHR - LI (3, 7, 13, 17)			

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray.

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

Notes:

1. Safe shutdown makeup pumps (SSMP) are credited for non-station blackout sequences.
2. PRA defines battery depletion at 4 hrs.
3. In sequences 3 and 4, either EAC or recovery of LOOP in 45 mins is successful.
4. In sequences 5 and 6, either EAC or recovery of LOOP in 4 hrs is successful.

PHASE 2 RISK ESTIMATION WORKSHEET **ATWS**

Estimated Frequency (Table 1 Row) V Exposure time 12 days Table 1 result (circle): A B C D E (F) G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Over pressure Protection (OVERP)	11 /13 RVS/SRVs (1 multi-train system)
Reactivity Control (SLC)	1/ 2 SLC train (high stress operator action)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
High Press Injection (HPI)	HPCI (1 ASD train) or RCIC (1 ASD train) or 1/3 Feedwater pumps (1 multi-train system) or SSMP (operator action)
Depressurization (DEP)	1/5 ADS valves manually opened (high stress operator action)
Low Pressure Injection (LPI)	1/4 RHR trains in LPCI mode (1 multi-train system) or 1/2 LPCS train (1 multi-train system)
Inhibit ADS and LVI Control (INH)	Operator inhibits ADS and controls RPV level (High stress operator action)
Containment Heat Removal (CHR)	1/4 RHR pumps with HX and 1/4 RHRSW pump in SPC (1 multi-train system) or SBCS (high stress operator action) or containment venting (high stress operator action)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence:	Sequence Color
1 ATWS - OVERP (10)			
2 ATWS - SLC (7)			
3 ATWS - RPT (9)			
4 ATWS - **HPI** - DEP (6)	**1 (RCIC)**	**(HPCI = 1) + (FW = 3) + (SSMP = 2) + (DEP = 1) Total = 8**	**F8** Green
5 ATWS - **HPI - LPI** (5)	**1(RCIC,LPCS)**	**(HPCI = 1) + (FW = 3) + (SSMP = 2) + (RHR = 3) + (LPCS = 2) Total = 12**	**F12** Green
6 ATWS - INH (8)			
7 ATWS - CHR (2, 4)			

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

Operator action for the recovery of RCIC and Core Spray.

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and available and ready for use.

Notes:

1. The standby liquid control system (SLC) is manually operated and reactivity control with SLC is considered high stress operator action. PRA assigns a failure probability of 4.5 E-2.
2. Operators inhibit ADS and LVI control (INH) is considered a high stress operator action, PRA assigns a failure probability of 3.0 E-3.

Initiating Event Likelihood	Remaining Mitigation Capability Rating (with Examples)						
	6	**5**	**4**	**3**	**2**	**1**	**0**
	3 diverse trains OR 2 multi-train systems OR 1 train + 1 multi-train system + recovery of failed train	1 train + 1 multi-train system OR 2 diverse trains + recovery of failed train	2 diverse trains OR 1 multi-train system + recovery of failed train	1 train + recovery of failed train OR 1 multi-train system OR Operator action + recovery of failed train	1 train OR Operator action OR Operator action under high stress + recovery of failed train	Recovery of failed train OR Operator action under high stress	none
A	Green	White	Yellow	Red	Red	Red	Red
B	Green	Green	White	Yellow	Red	Red	Red
C	Green	Green	Green	White	Yellow	Red	Red
D	Green	Green	Green	Green	White	Yellow	Red
E	Green	Green	Green	Green	Green	White	Yellow
F	Green	Green	Green	Green	Green	Green	White
G	Green	Green	Green	Green	Green	Green	Green
H	Green	Green	Green	Green	Green	Green	Green

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)